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| **L2HE SPQA PRE-ALIGNMENT PROCEDURE** |
| **Document Number:** | L2HE-PR-CMA-SPQA-ALIGN | **Effective Date:** | 18 Dec 2023 |
| **Revision Number:** | 1 | **Periodic Review Date:** | DD Mmm YYYY |
| **Document Owner:** | Steve Hardisty/John Fischer | **Department Owner:** | SRF Operations |

# Purpose

The purpose of this document is to provide guidance on the alignment of the SPQA once it has been added to the Cavity string at Work Station 2.

# Scope

This procedure applies specifically to L2HE cryomodule assembly efforts. It is not intended for any other Cryomodule type. The work is to be performed by Trained personnel only.

# Terms and Definitions

The following terms have specific meanings within this procedure.

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| **Term** | **Definition** |
| Fiducial | Specific tool location used to determine coordinates |
| Coordinate system | X, Y, Z, Locations of a measured item in consistent relationship |
| SPQA | L2HE specific beam line magnet installed at WS2 |

# Roles and Responsibilities

The following roles have responsibilities described in this document.

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| **Role** | **Responsibility** |
| JLAB Alignment Lead | Directs the execution of this Procedure and verifies final data taken is correct. |
| Alignment Technician | Performs the alignment adjustment and measurements |
| Cryomodule Assembly Technician | Working with the Alignment personnel performs adjusting activities in support of the alignment process |
| Cryomodule Assembly Group Lead | Provides technician support and reviews final data  |

# Procedure

**INITIAL EACH STEP AFTER COMPLETION**

**Note:** Quad fiducials (accepts 7/8” probe or SMR) come from FERMI magnetic mapping. Signs need to be changed as coordinate system during mapping differs from as installed. Fiducials are stamped to insure correct absolute value. Spreadsheet from previous quad data (SPQAxxxFERMI) can be used as a reference. Quad coordinate systems are now consistently similar.

1: Set PCMM up to reach cavity 8 flanges and quad fids, calibrate using 7/8”probe.

2: Coordinate system is established off cavity 8 upstream and downstream flanges for Z axis, Thomson rails for roll about Z axis, and Z=0 on coupler flange. The primary purpose pre-aligning the quad is to set the rotation angles and shim the gaps on the upstream support flange. Note that the need for shimming the support flange gap on 1 side was a problem early on as the two halves were shifted along Z. Recently the quad construction has improved.

3: Loosen the 8 bolts connecting the BPM to the quad. DO NOT LOOSEN BEAM PIPE FLANGE UNDER VACUUM. Align the downstream BPM flange and the downstream gate valve flange onto XY=0.0 within 0.25mm. This has to be done first to allow adjustment of quad as the gap between the beam pipe and quad aperture is limited. The quad lower supports may have to be loosened or adjusted to achieve alignment.

4: Adjust the quad for pitch and yaw. Note that this is not the usual sequence to align a component as normally roll would be set first. The clearance in the bolt holes are only 0.5mm so in order to maximize clearance for roll, pitch and yaw need to be set first. Set the roll (rotation about the Z axis). If the tolerance of <3mrad (0.171 deg) cannot be achieved, the upstream threaded attachment bolts may have to be modified (see John Fischer). For pitch and yaw, 3mrad is about +- 0.4 error between fiducials and roll is about +-0.23mm between fiducials. Note that this is maximum error based on alignment inside the vacuum vessel so try to cut these tolerances in half.

5: Lock the upstream bolts which close the gap between the quad and BPM flange leaving the others loose where a gap is seen. Measure the gaps at each bolt which is not tightened for shim packs, loosen the bolts and shim between. A thousandth or 2 can be added to the shim packs to make up any torque corrections. Tighten all upstream bolts with shim installed.

6: Re-set pitch and yaw, check roll and set for XY and Z alignment. Tolerance for XYZ is approximately 1mm as this just lessens alignment time when attached to UCM. Z should be 369.4 mm from cavity8 coupler flange to upstream face of upstream dog ear beam left side. Measure a plane (4 POINTS) on upstream side of the upstream beam left dog ear .

# References

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| **Document No.** | **Title** |
| SRF-01-ML-001 | SRF Quality Manual |
|  | [L2HE SPQA Installation Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-278978/LCLS%20Quad%20Magnet%20Install-f.docx) |
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# Release and Revision History

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| **Rev #** | **Major Changes** | **Effective Date:** |
| 1 | Initial version | 02 Jan 2024 |

# Approvals

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